
Supplemental Information Report

March 1996

American River Watershed Project, California

Volume 2 - Appendix E (Part 1)



US Army Corps
of Engineers
Sacramento District



The Reclamation Board
State of California



Sacramento Area
Flood Control Agency

RAISING FOLSOM DAM

Existing Folsom Dam

Folsom Dam consists of a 345-foot high concrete gravity dam across the American River channel, the left and right wing dams, Mormon Island Dam, and eight saddle dikes. The left and right wing dams abut and flank the ends of the concrete dam section. Eight saddle dikes and Mormon Island Dam (constructed across Blue Ravine) are located in various reaches around the perimeter of Folsom Lake. Dikes 1 through 6 are positioned northeast of the right wing dam; Dikes 7 and 8 and Mormon Island Dam are south of the left wing dam.

Folsom Lake impounds the runoff from 1,861 square miles and has a storage capacity of 974,000 acre-feet. The reservoir is contained by 5.05 miles of dams and dikes that have, in general, a crest elevation of 480.5 feet above sea level. At gross pool, Elevation 466.0 feet, there is 14.5 feet of freeboard. Only during major floods does the pool exceed Elevation 466.0 feet.

Proposed Modifications

Two proposed options of providing additional reservoir storage capacity were raising Folsom Dam 30 feet (additional 366,000 acre-feet) and 17 feet (additional 199,000 acre-feet). The proposed structural modifications to the concrete dam section, the left and right wing dams, Mormon Island Dam and eight saddle dikes are provided below. For both the 30-foot and 17-foot raise, structural modifications incorporate similar concepts except for the concrete dam section. Spillway rating curves for the 30-foot and 17-foot raise dams are shown on Plates 313 and 314.

Concrete Dam Section - 30-foot Raise

The concrete dam section would be extended on each end resulting in an additional 150 feet of concrete crest length for the new right wing block and an additional 85 feet of concrete crest length for the new left wing block (see plate 301). The excavation drawing is shown on plate 302. Also, concrete additions are required on the downstream face of the existing dam, increasing the thickness of the dam section by approximately 60 feet at foundation level (plate 303).

Plate 304 presents the section for the additional structure that is required for the service spillway and auxiliary spillway sections. The spillway basin would be extended 133 feet to compensate for the relocation of the spillway toe downstream that is caused by addition of concrete to the downstream face of the dam.

Concrete Dam Section - 17-foot Raise

The plan and sectional views and excavation drawings of raising the concrete dam and embankments would be similar to the 30-foot raise. The new concrete extensions on each end of the existing dam are an additional 104 feet of concrete for the new right wing block and 66 feet of concrete for the new left wing block. The concrete additions required on the downstream face of the dam increase the thickness of the dam at foundation level by approximately 50 feet. The spillway basin would be extended 115 feet.

Left Wing Dam

The left wing dam now reaches a maximum height of 145 feet, measures 2,100 feet in length, and has a crest width of 30 feet. The proposed raise includes extending the center core crest at side slopes of 0.25 H to 1 V (see plates 305 and 306). Transition zones between the base of the center core and the top of embankment would be extended upward, maintaining their current 12-foot width. A 30-foot or 17-foot thick layer of new shell material would be placed over the vast majority of the existing dam, with a 2-foot layer of riprap protecting the new upstream slope of the dam.

Right Wing Dam

The right wing dam now reaches a maximum height of 145 feet, measures 6,700 feet in length, and has a crest width of 30 feet, as shown on Plates 307 and 308. The proposed raise is analogous to the left wing dam. A special consideration for raising the right wing dam is placement of new fill at the upstream toe near Retaining Wall "B" (plate 301). The crest length for the new right wing block of the concrete dam was selected so that no new embankment fill would be needed above Retaining Wall "B." Thus, the new fill upstream on the right wing dam begins with zero thickness at the upstream end of the retaining wall and gradually builds to a 30-foot thickness some 280 feet away. Over most of this distance, the small wedge of toe fill must be placed below Elevation 330, which is the extent of drawdown required for work on the new concrete monolith.

Mormon Island Dam

Mormon Island Dam is a zoned embankment that has a crest length of 4,820 feet and reaches a maximum height of 165 feet, as measured from the base of the core trench. The raise concept presented in Plate 301 for Mormon Island Dam follows the pattern for the left and right wing dams.

Remedial construction is currently being performed at the dam to improve its performance during a major earthquake. For the dam raising, additional work will be required to address the seismic concerns for the higher dam. The remedial work would

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consist of installation of stone columns for approximately 135 feet upstream of the current dynamic compaction zone, installation of stone columns for approximately 105 feet downstream of the stone column installation presently underway, and installation of a mini-column drainage curtain (8 feet wide) at the downstream boundary of the additional stone columns (plate 310).

Dikes 1 Through 8

The eight dikes would be raised using the same materials used to construct the dikes. Plate 311 gives details of the existing and raised dikes in plan and sectional views.

A 30-foot or 17-foot thick layer of new shell material would be placed over the vast majority of the existing dike, with a layer of riprap protecting the new upstream slope of the dike. A new coarse filter and drain would be placed along the upstream and downstream slopes of the dikes (plate 309).

The crest roadway needs to be raised and reconstructed from the end of the Left Wing Dam out to the vicinity of Dike 7. The existing access road passes through a saddle between the Left Wing Dam and Dike 7 that has a low point at approximately Elevation 496. It will be necessary to construct a new minor dike to close this low point in conjunction with the raising and reconstructing the access road.

Construction Techniques, Equipment, and Schedule

Approximately 2,932,000 cubic yards of embankment fill would be required for raising the existing wing dams and dikes. Rock and concrete debris will be hauled to the Sacramento County landfill at Grant Line and Kiefer Roads for disposal. Any steel removed will be recycled by the contractor.

The reservoir drawdown schedule for raising Folsom Dam is shown on plate 312. Most of the construction activity will occur from March to October. Only construction that will not endanger the dam's capability to control and pass flood events will be allowed during flood season (November to February).

It is important to note that the public roadway existing across the top of the left wing dam, the concrete dam section, and down the downstream slope of the right wing dam is incompatible with construction activities. The road will have to be closed and traffic diverted. A new bridge would be constructed before work could begin on raising the dam.

It is essential that each new wing block of the concrete dam section be completed in a single non-flood season. In each case, embankment excavation adjacent to the concrete dam section must begin as early as possible in the spring, giving time for foundation placement,

roller compacted concrete (RCC) placement, and restoration of the enveloping embankment at least to elevation 480.5 feet prior to the start of the next flood season. The two wing blocks would probably be constructed in separate construction seasons for these critical dam elements.

For all above-ground work, typical construction methods and equipment were assumed. For underground work (excavation, concreting and grouting) drill and blast methods would be used. For reinforced concrete work, standard methods for batching, mixing, hauling, and placing would be used. A conveyor system and a continuously mixing system would be used for handling of RCC.

The equipment schedule for raising Folsom Dam is shown on Table V-94.

Cost Estimate

The total investment cost (October 1995 price level, 7.625 percent interest rate), including interest during construction would be about \$766.72 million for the 30-foot raise (see Table V-95). Average annual costs are about \$58.54 million.

The total investment cost, including interest during construction would be about \$533.68 million for the 17-foot raise (see Table V-96). Average annual costs are about \$40.76 million.

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Table V-94
Raise Folsom Dam
Daily Equipment Operation-Year 1

	JAN	FEB	MAR	APR	MAY	JUN
(1) Equipment Maintenance (Refueling, Oiling, etc.)	0500-0700	0500-0700	0500-0700	0500-0700	0500-0700	0500-0700
(2) 2 Cranes	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(3) 4 Compressors	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(4) 2 Barges	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(5) 1 Drill Rig	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(6) 10 Concrete Trucks			0700-1600	0700-1600	0700-1600	0700-1600
(7) 2 Concrete Pumps			0700-1600	0700-1600	0700-1600	0700-1600
(8) 20 Miscellaneous Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(9) 1 Front End Loader	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(10) 10 Dump Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(11) 1 Grader	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(12) 1 Concrete Paving machine						
(13) 1 Backhoe						
(14) 3 Asphalt Trucks					0700-1600	0700-1600
(15) 1 Compactor					0700-1600	0700-1600
(16) 1 Roller						
(17) 2 Water Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600

	JUL	AUG	SEP	OCT	NOV	DEC
(1) Equipment Maintenance (Refueling, Oiling, etc.)	0500-0700	0500-0700	0500-0700	0500-0700	0500-0700	0500-0700
(2) 2 Cranes	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(3) 4 Compressors	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(4) 2 Barges	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(5) 1 Drill Rig	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(6) 10 Concrete Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(7) 2 Concrete Pumps	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(8) 20 Miscellaneous Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(9) 1 Front End Loader	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(10) 10 Dump Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(11) 1 Grader	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(12) 1 Concrete Paving machine				0700-1600	0700-1600	0700-1600
(13) 1 Backhoe	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(14) 3 Asphalt Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(15) 1 Compactor	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600
(16) 1 Roller				0700-1600	0700-1600	0700-1600
(17) 2 Water Trucks	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600	0700-1600

Note: Schedule is based on 24-hour clock and assumed 6 days per week.

Table V-94 (continued)
Raise Folsom Dam
Daily Equipment Operation-Years 2-7

	JAN	FEB	MAR	APR	MAY	JUN
(1) Equipment Maintenance (Refueling, Oiling, etc.)	0500-0700	0500-0700	0500-0700	0300-0500	0300-0500	0300-0500
(2) 2 Cranes	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(3) 4 Compressors	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(4) 4 Bulldozers	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(5) 2 Drill Rig	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(6) 20 Concrete Trucks	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(7) 4 Concrete Pumps	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(8) 20 Miscellaneous Trucks	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(9) 1 Front End Loader	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(10) 10 Dump Trucks	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(11) 1 Grader	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(12) 6 Scapers	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(13) 1 Backhoe	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400
(14) 4 Compactors						
(15) 2 Rollers						
(16) 2 Water Trucks	0700-1600	0700-1600	0700-1600	0500-2400	0500-2400	0500-2400

	JUL	AUG	SEP	OCT	NOV	DEC
(1) Equipment Maintenance (Refueling, Oiling, etc.)	0300-0500	0300-0500	0300-0500	0500-0700	0500-0700	0500-0700
(2) 2 Cranes	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(3) 4 Compressors	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(4) 4 Bulldozers	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(5) 2 Drill Rig	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(6) 20 Concrete Trucks	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(7) 4 Concrete Pumps	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(8) 20 Miscellaneous Trucks	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(9) 1 Front End Loader	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(10) 10 Dump Trucks	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(11) 1 Grader	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(12) 6 Scapers	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(13) 1 Backhoe	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(14) 4 Compactors	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(15) 2 Rollers	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600
(16) 2 Water Trucks	0500-2400	0500-2400	0500-2400	0700-1600	0700-1600	0700-1600

Note: Schedule is based on 24-hour clock and assumed 6 days per week.

Flood Control Measures

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D-003348

D-003348

Table V-95
Folsom Dam Raising 30 feet - Cost Estimate
(October 1995 Price Level, 7.625 Percent Interest Rate)

Item	Cost
First Cost	
Concrete Dam Section	
General Items	\$ 6,680,000
Roads	1,500,000
Concrete Dam	184,230,000
Right Wing Dam	
General Items	1,600,000
Roads	870,000
Earth Wing Dam	54,350,000
Left Wing Wall Dam	
General Items	430,000
Roads	870,000
Concrete Dam	14,010,000
Dike 1	
General Items	570,000
Roads	650,000
Earth Wing Dam	5,670,000
Dike 2	
General Items	520,000
Roads	450,000
Earth Wing Dam	3,820,000
Dike 3	
General Items	530,000
Roads	530,000
Concrete Dam	4,670,000

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Table V-95 (continued)
Folsom Dam Raising 30 feet - Cost Estimate
(October 1995 Price Level, 7.625 Percent Interest Rate)

Item	Cost
Dike 4	
General Items	80,000
Roads	200,000
Earth Wing Dam	3,310,000
Dike 5	
General Items	170,000
Roads	200,000
Concrete Dam	8,170,000
Dike 6	
General Items	100,000
Roads	220,000
Earth Wing Dam	4,680,000
Dike 7	
General Items	60,000
Roads	190,000
Earth Wing Dam	2,760,000
Dike 8	
General Items	200,000
Roads	230,000
Earth Wing Dam	1,750,000
Mormon Island	
General Items	270,000
Roads	300,000
Earth Wing Dam	66,400,000

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D - 0 0 3 3 5 0

D-003350

Table V-95 (continued)
Folsom Dam Raising 30 feet - Cost Estimate
(October 1995 Price Level, 7.625 Percent Interest Rate)

Item	Cost
New Folsom Bridge	46,860,000
Contingencies	125,460,000
E & D and S & A	111,450,000
Total First Cost	\$655,110,000
Investment Cost	
Total First Cost	655,110,000
IDC	111,610,000
Total	\$766,720,000
Annual Cost	
Interest and Amortization	58,500,000
Operation and Maintenance	40,000
Total	\$ 58,540,000

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Table V-96
Folsom Dam Raising 17 feet - Cost Estimate
(October 1995 Price Level, 7.625 Percent Interest Rate)

Item	Cost
First Cost	
Concrete Dam Section	
General Items	\$ 6,680,000
Roads	1,480,000
Concrete Dam	122,630,000
Right Wing Dam	
General Items	1,390,000
Roads	880,000
Earth Wing Dam	31,270,000
Left Wing Wall Dam	
General Items	320,000
Roads	870,000
Concrete Dam	8,530,000
Dike 1	
General Items	430,000
Roads	620,000
Earth Wing Dam	3,070,000
Dike 2	
General Items	430,000
Roads	450,000
Earth Wing Dam	2,060,000
Dike 3	
General Items	530,000
Roads	520,000
Concrete Dam	2,270,000

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Table V-96 (continued)
Folsom Dam Raising 17 feet - Cost Estimate
(October 1995 Price Level, 7.625 Percent Interest Rate)

Item	Cost
Dike 4	
General Items	80,000
Roads	200,000
Earth Wing Dam	1,750,000
Dike 5	
General Items	170,000
Roads	190,000
Concrete Dam	5,070,000
Dike 6	
General Items	100,000
Roads	220,000
Earth Wing Dam	2,720,000
Dike 7	
General Items	60,000
Roads	190,000
Earth Wing Dam	1,600,000
Dike 8	
General Items	160,000
Roads	220,000
Earth Wing Dam	870,000
Mormon Island	
General Items	270,000
Roads	300,000
Earth Wing Dam	43,610,000

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D - 0 0 3 3 5 3

Table V-96 (continued)
Folsom Dam Raising 17 feet - Cost Estimate
(October 1995 Price Level, 7.625 Percent Interest Rate)

Item	Cost
New Folsom Bridge	46,860,000
Contingencies	86,690,000
E & D and S & A	80,770,000
Total First Cost	456,440,000
Investment Cost	
Total First Cost	456,440,000
IDC	77,240,000
Total	\$533,680,000
Annual Cost	
Interest and Amortization	40,720,000
Operation and Maintenance	40,000
Total	\$ 40,760,000

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